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EXAMINER

WERNER, BRIAN P

| ART UNIT | PAPER NUMBER |
|----------|--------------|
|----------|--------------|

2621

DATE MAILED: 05/12/2003

20

Please find below and/or attached an Office communication concerning this application or proceeding.

16

Office Action Summary

Application No.

09/294,137

Applicant(s)

MAEDA ET AL.

Examiner

Brian P. Werner

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 19 February 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,2,4-15 and 17-36 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,2,4-15 and 17-36 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 11 March 2002 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ 6) ☐ Other: _____

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on December 16, 2002 has been entered.

Response to Amendment

2. The amendment received on December 16, 2002 has been entered. Claims 1, 2, 4-15 and 17-36 remain pending.

Drawings

3. The formal drawings received on March 11, 2002 are acceptable.

Response to Arguments

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4. Applicant's arguments with respect to each of the pending claims have been considered:

Pending Claims

Summary of Applicant's Remarks: The pending claims are 1, 2, 4-15 and 17-36.

Examiner's Response: Examiner agrees.

Prior Art Rejections (Independent Claims)

Summary of Applicant's Remarks: Independent claim 1, which was not amended, as well as the remaining independent claims which have been amended, all recite, "a local gradation conversion is performed to locally match a brightness of the first image with a brightness of the second image". This claimed feature is not taught by the prior art of record.

Examiner's Response: While the examiner disagrees with applicant's assertion that Lee's gradation conversion is not "local", the rejections have nevertheless been modified with prior art that more clearly teaches this feature. Therefore, applicant's arguments are moot in view of the new grounds of rejection.

Prior Art Rejections (Dependent Claims)

Summary of Applicant's Remarks: Dependent claims 31-36 are not taught by the prior art of record.

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Examiner's Response: Applicant's arguments are moot in view of the new grounds of rejection.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 1, 4, 8-14 and 22-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Lee et al. (US 5,808,735 A – art of record), Danielson et al. (US 4,926,489 A – new art) and Koike et al. (US 6,181,805 B1).

Lee discloses a system that aligns and compares first and second images (i.e., a test and reference image of a semiconductor) to detect defects. The content of the Lee reference as addressed the previous Office Actions is incorporated herein by reference, and will not be repeated for the sake of brevity. Only the differences between Lee and the claims and the elements argued by applicant as not taught by Lee will be discussed.

First Difference:

Lee does not disclose the alignment accuracy; other than it is “conventional alignment” at column 4, line 54. Specifically, Lee does not teach the alignment of the two images with an accuracy of one pixel unit.

Second Difference:

While Lee discloses gradation conversion means for performing gradation conversion to correct a brightness, and thereby match the brightness of one image to that of the other (i.e., "test and reference images differ slightly in intensity" and the "system 20 compensates for these normal intensity differences (step 220) by providing an intensity offset" at column 6, line 15; figure 2A, numeral 220; "normalized for intensity" at column 6, line 42; as described at column 6, lines 30-33, the intensity values of the images are made to correspond more closely with one-another, or corrected with respect to one-another, based on a histogram of differences), Lee does not teach a "local" gradation conversion of one of the first or second images to "locally match a brightness of the first image with a brightness of the second image" as claimed.

Regarding the first difference, Danielson discloses a system in the same field of substrate pattern inspection (figure 1; the mask is depicted as numeral 24) and same problem solving area of image alignment (figure 1, numeral 66), comprising an alignment means for aligning first and second images (figure 1, numeral 66) with an accuracy of one pixel unit ("alignment system includes ... detection of alignment errors in excess of +/- 1 pixel" at column 6, line 11).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to align the two images as required by Lee, with an accuracy of one pixel unit using the alignment means taught by Danielson, in order to "compensate for registration errors present when comparison of a [substrate] is made ... where spatial resolution of the automatic system is very high and the inspection speed rapid" (Danielson, column 6, line 2), such that "alignment can be properly maintained in the

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presence of large areas devoid of patterns" (Danielson, column 6, line 19), and ultimately to provide a "high speed, continuous process" where "no stopping or restriction of the pixel stream is necessary, and continuous correction of alignment can be performed" (Danielson, column 14, line 60).

Regarding the second difference, Koike discloses a system in the same field of image processing, and specifically in the same sub-field of matching a source image with a reference image through image comparison ("image of an object having features ... matched to dictionary or library images" at column 1, lines 6-8), wherein Koike solves the same problem of matching brightness between the two images (i.e., "normalization sec." At figure 20, numerals 137 and 138). Koike teaches a local gradation conversion ("normalizing the brightness or lighting of the matching region" at column 14, line 47; a "region" is local within the image) of one of the first or second images (figure 20, numerals 137 and 138) to locally match a brightness of the first image with a brightness of the second image ("normalizing the brightness or lighting of the matching region in the test image and the dictionary image" at column 14, line 47; "transforming the intensity values of the respective pixels so that the mean value and the variance of the intensity of pixels in the matching region may coincide with predetermined values" or "convert, nonlinearly, the range between the maximum and minimum value of the intensity of pixels in the matching region to a range between predetermined maximum and minimum values" at column 14, lines 60+; "Owing to the normalization processing, it is possible to prevent lowering of the matching accuracy when the brightness of the

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object in the test image varies with a change in pose of the object, for example” at column 15, line 12).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to modify the brightness normalization of Lee (i.e., Lee’s global gradation conversion at Lee’s figure 2A, numeral 220), to locally match brightness specifically at matching “regions” as taught by Koike, in order to prevent lowering of the matching accuracy when the brightness of the features in the test image varies from that of the reference image due to changes in ambient measurement conditions (i.e., as described by Koike at column 15, line 12).

7. Claims 1, 4, 8-14 and 22-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Lee et al. (US 5,808,735 A – art of record), Danielson et al. (US 4,926,489 A – new art) and Michael (US 5,640,200 A).

Lee discloses a system that aligns and compares first and second images (i.e., a test and reference image of a semiconductor) to detect defects. The content of the Lee reference as addressed the previous Office Actions is incorporated herein by reference, and will not be repeated for the sake of brevity. Only the differences between Lee and the claims and the elements argued by applicant as not taught by Lee will be discussed.

First Difference:

Lee does not disclose the alignment accuracy; other than it is “conventional alignment” at column 4, line 54. Specifically, Lee does not teach the alignment of the two images with an accuracy of one pixel unit.

Second Difference:

While Lee discloses gradation conversion means for performing gradation conversion to correct a brightness, and thereby match the brightness of one image to that of the other (i.e., "test and reference images differ slightly in intensity" and the "system 20 compensates for these normal intensity differences (step 220) by providing an intensity offset" at column 6, line 15; figure 2A, numeral 220; "normalized for intensity" at column 6, line 42; as described at column 6, lines 30-33, the intensity values of the images are made to correspond more closely with one-another, or corrected with respect to one-another, based on a histogram of differences), Lee does not teach a "local" gradation conversion of one of the first or second images to "locally match a brightness of the first image with a brightness of the second image" as claimed.

Regarding the first difference, Danielson discloses a system in the same field of substrate pattern inspection (figure 1; the mask is depicted as numeral 24) and same problem solving area of image alignment (figure 1, numeral 66), comprising an alignment means for aligning first and second images (figure 1, numeral 66) with an accuracy of one pixel unit ("alignment system includes ... detection of alignment errors in excess of +/- 1 pixel" at column 6, line 11).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to align the two images as required by Lee, with an accuracy of one pixel unit using the alignment means taught by Danielson, in order to "compensate for registration errors present when comparison of a [substrate] is made ... where spatial resolution of the automatic system is very high and the inspection speed rapid"

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(Danielson, column 6, line 2), such that "alignment can be properly maintained in the presence of large areas devoid of patterns" (Danielson, column 6, line 19), and ultimately to provide a "high speed, continuous process" where "no stopping or restriction of the pixel stream is necessary, and continuous correction of alignment can be performed" (Danielson, column 14, line 60).

Regarding the second difference, Michael discloses a system in the same field of image processing, and specifically in the same sub-field of comparing a image of a wafer with a reference to detect defects (figure 7), wherein Michael solves the same problem of matching brightness between the two images ("contrast normalization" at column 13, line 65). Michael teaches both a global gradation conversion (i.e., column 13, line 65) and a local gradation conversion ("local contrast normalization" at column 14, line 32) to locally to locally match a brightness of the first image with a brightness of the second image (equation 6 at column 14, line 40).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to modify the brightness normalization of Lee (i.e., Lee's global gradation conversion at Lee's figure 2A, numeral 220), to also locally match brightness as taught by Michael, in order to prevent improve matching accuracy by compensating for "conditions that cause image intensity to vary slowly with position in the image" (Michael, column 14, line 35).

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8. Claims 1, 4, 8-14 and 22-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Lee et al. (US 5,808,735 A – art of record), Danielson et al. (US 4,926,489 A – new art) and Schemmel et al. (US 6,504,948 B1).

Lee discloses a system that aligns and compares first and second images (i.e., a test and reference image of a semiconductor) to detect defects. The content of the Lee reference as addressed the previous Office Actions is incorporated herein by reference, and will not be repeated for the sake of brevity. Only the differences between Lee and the claims and the elements argued by applicant as not taught by Lee will be discussed.

First Difference:

Lee does not disclose the alignment accuracy; other than it is “conventional alignment” at column 4, line 54. Specifically, Lee does not teach the alignment of the two images with an accuracy of one pixel unit.

Second Difference:

While Lee discloses gradation conversion means for performing gradation conversion to correct a brightness, and thereby match the brightness of one image to that of the other (i.e., “test and reference images differ slightly in intensity” and the “system 20 compensates for these normal intensity differences (step 220) by providing an intensity offset” at column 6, line 15; figure 2A, numeral 220; “normalized for intensity” at column 6, line 42; as described at column 6, lines 30-33, the intensity values of the images are made to correspond more closely with one-another, or corrected with respect to one-another, based on a histogram of differences), Lee does

not teach a "local" gradation conversion of one of the first or second images to "locally match a brightness of the first image with a brightness of the second image" as claimed.

Regarding the first difference, Danielson discloses a system in the same field of substrate pattern inspection (figure 1; the mask is depicted as numeral 24) and same problem solving area of image alignment (figure 1, numeral 66), comprising an alignment means for aligning first and second images (figure 1, numeral 66) with an accuracy of one pixel unit ("alignment system includes ... detection of alignment errors in excess of +/- 1 pixel" at column 6, line 11).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to align the two images as required by Lee, with an accuracy of one pixel unit using the alignment means taught by Danielson, in order to "compensate for registration errors present when comparison of a [substrate] is made ... where spatial resolution of the automatic system is very high and the inspection speed rapid" (Danielson, column 6, line 2), such that "alignment can be properly maintained in the presence of large areas devoid of patterns" (Danielson, column 6, line 19), and ultimately to provide a "high speed, continuous process" where "no stopping or restriction of the pixel stream is necessary, and continuous correction of alignment can be performed" (Danielson, column 14, line 60).

Regarding the second difference, Schemmel discloses a system in the same field of image processing, and specifically in the same sub-field of matching a source wafer image with a reference wafer image through image comparison (figures 1, 2 and 5), wherein Schemmel solves the same problem of matching brightness between the two

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images (i.e., “variations in ... background reflectivity” at column 12, line 21). Schemmel teaches a local gradation conversion to locally match a brightness of the first image with a brightness of the second image (“automatically adjusts the relative gray scale values recorded for each neighborhood of pixels within a silicon chip” at column 12, line 25).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to modify the brightness normalization of Lee (i.e., Lee’s global gradation conversion at Lee’s figure 2A, numeral 220), to locally match brightness specifically at “neighborhoods” as taught by Schemmel, in order to compensate for variation in background reflectivity and “intrinsic variations in the processing of different batches of silicon wafers” (Schemmel, column 12, lines 20-25) thus preventing the false identification of defects due to normal variations between a test and a reference image.

9. Claim 1, 5, 7, 15, 21 and 27-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Lebeau (US 5,204,910 – art of record), Kobayashi et al. (US 4,669,123 – art of record), Danielson et al. (US 4,926,489 A – new art) and Koike et al. (US 6,181,805 B1).

Lebeau discloses a system that aligns and compares first and second images (i.e., a test and reference image of a semiconductor) to detect defects. More specifically, discloses the alignment (“registered” and “rotation and spatial position” at column 3, line 60) and comparison of images of patterns in two images (“compared by algebraically subtracting the respective graylevel values at each pixel location” at column 6, line 56; “bright defects” and “dark defects” are detected at column 7, line 24).

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The content of the Lebeau reference was addressed in the previous Office Actions; the details of which are incorporated herein by reference and will not be repeated for the sake of brevity.

First Difference:

Lebeau does not teach the image of the second pattern being formed on the same substrate as the first.

Second Difference:

Lebeau does not teach the aligning having an accuracy of one pixel unit.

Third Difference:

While Lebeau discloses gradation conversion means for performing gradation conversion to match a brightness of one image to that of the other (i.e., the graylevels of the “[r]un image ... are then mapped based on a comparison of the mean brightness of the taught image to that of the run image” so “the mean brightness level ... is the same as the mean value of taught image” at column 5, lines 50-54), Lebeau does not teach a “local” gradation conversion of one of the first or second images to “locally match a brightness of the first image with a brightness of the second image” as claimed.

Regarding the first difference (i.e., the claim limitation that requires the image of the second pattern to be formed on the same substrate as the first), Kobayashi discloses a system in the same field of semiconductor defect inspection (“inspecting method and apparatus” and “semiconductor device” at column 1, line 7), wherein Kobayashi teaches comparing images of first and second patterns picked-up from the same substrate (“pattern comparing method one unit pattern is compared with another

unit pattern having the same shape and size" at column 1, line 23). Kobayashi describes how the traditional "database comparing method requires a lot of inspecting time and covers a lot of design data" (column 1, line 27) and that "the pattern comparing method is preferable to the database comparing method for inspection of complex photomask patterns" (column 1, line 29).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to modify the Lebeau system by picking up both the taught and run images from the same substrate as taught by Kobayashi, thus realizing the benefits of the pattern comparing method taught by Kobayashi including the reduction of inspection time when inspecting the complex patterns of a semiconductor device, and eliminating the need to process and store a reference for comparison (as the normally identical semiconductor devices on a wafer are compared with each other).

Regarding the second difference (i.e., the claim limitation that requires alignment to a single pixel unit), Danielson discloses a system in the same field of substrate pattern inspection (figure 1; the mask is depicted as numeral 24) and same problem solving area of image alignment (figure 1, numeral 66), comprising an alignment means for aligning first and second images (figure 1, numeral 66) with an accuracy of one pixel unit ("alignment system includes ... detection of alignment errors in excess of +/- 1 pixel" at column 6, line 11).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to align the two images as required by the above Lebeau and Kobayashi combination, with an accuracy of one pixel unit using the alignment means taught by

Danielson, in order to "compensate for registration errors present when comparison of a [substrate] is made ... where spatial resolution of the automatic system is very high and the inspection speed rapid" (Danielson, column 6, line 2), such that "alignment can be properly maintained in the presence of large areas devoid of patterns" (Danielson, column 6, line 19), and ultimately to provide a "high speed, continuous process" where "no stopping or restriction of the pixel stream is necessary, and continuous correction of alignment can be performed" (Danielson, column 14, line 60).

Regarding dependent claims 7 and 27 specifically, while Lebeau teaches "recording locations of bright defects 56 and dark defects 54 for later analysis" at column 7, line 24, Lebeau does not specifically teach displaying the detected defects and the information of features of the detected defects on a screen.

Kobayashi also teaches displaying the detected defects and information of features of the detected defects on a screen ("human inspector can check the inspection results by observing the stored data in the stage coordinate memory 300 on the inspection output device 400 such as a cathode-ray tube" at column 4, line 12; the features include "the stage position at which there is a defect" at line 5; thus, given that each defect detected is output to the operator on a CRT, the defects are displayed; that the claim does not require any particular form of visual display, only that the defects are displayed; also, given that the coordinates of where the defect exists are displayed, information about the defects is displayed).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to display the detected defects and information of detected defect features

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on a screen in the Lebeau, Kobayashi and Danielson combination as further taught by Kobayashi, in order to allow a human operator to immediately and visually review and analyze the results of inspection and thus take immediate action, or make decisions regarding the inspected semiconductor under inspection.

Regarding the third difference, Koike discloses a system in the same field of image processing, and specifically in the same sub-field of matching a source image with a reference image through image comparison ("image of an object having features ... matched to dictionary or library images" at column 1, lines 6-8), wherein Koike solves the same problem of matching brightness between the two images (i.e., "normalization sec." At figure 20, numerals 137 and 138). Koike teaches a local gradation conversion ("normalizing the brightness or lighting of the matching region" at column 14, line 47; a "region" is local within the image) of one of the first or second images (figure 20, numerals 137 and 138) to locally match a brightness of the first image with a brightness of the second image ("normalizing the brightness or lighting of the matching region in the test image and the dictionary image" at column 14, line 47; "transforming the intensity values of the respective pixels so that the mean value and the variance of the intensity of pixels in the matching region may coincide with predetermined values" or "convert, nonlinearly, the range between the maximum and minimum value of the intensity of pixels in the matching region to a range between predetermined maximum and minimum values" at column 14, lines 60+; "Owing to the normalization processing, it is possible to prevent lowering of the matching accuracy when the brightness of the

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object in the test image varies with a change in pose of the object, for example” at column 15, line 12).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to modify the brightness normalization of Lebeau (i.e., the graylevels of the “[r]un image ... are then mapped based on a comparison of the mean brightness of the taught image to that of the run image” so “the mean brightness level ... is the same as the mean value of taught image” at Lebeau’s column 5, lines 50-54), to locally match brightness specifically at matching “regions” as taught by Koike, in order to prevent lowering of the matching accuracy when the brightness of the features in the test image varies from that of the reference image due to changes in ambient measurement conditions (i.e., as described by Koike at column 15, line 12).

10. Claim 1, 5, 7, 15, 21 and 27-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Lebeau (US 5,204,910 – art of record), Kobayashi et al. (US 4,669,123 – art of record), Danielson et al. (US 4,926,489 A – new art) and Michael (US 5,640,200 A).

Lebeau discloses a system that aligns and compares first and second images (i.e., a test and reference image of a semiconductor) to detect defects. More specifically, discloses the alignment (“registered” and “rotation and spatial position” at column 3, line 60) and comparison of images of patterns in two images (“compared by algebraically subtracting the respective graylevel values at each pixel location” at column 6, line 56; “bright defects” and “dark defects” are detected at column 7, line 24).

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Second Difference:

Lebeau does not teach the aligning having an accuracy of one pixel unit.

Third Difference:

While Lebeau discloses gradation conversion means for performing gradation conversion to match a brightness of one image to that of the other (i.e., the graylevels of the "[r]un image ... are then mapped based on a comparison of the mean brightness of the taught image to that of the run image" so "the mean brightness level ... is the same as the mean value of taught image" at column 5, lines 50-54), Lebeau does not teach a "local" gradation conversion of one of the first or second images to "locally match a brightness of the first image with a brightness of the second image" as claimed.

Regarding the first difference (i.e., the claim limitation that requires the image of the second pattern to be formed on the same substrate as the first), Kobayashi discloses a system in the same field of semiconductor defect inspection ("inspecting method and apparatus" and "semiconductor device" at column 1, line 7), wherein Kobayashi teaches comparing images of first and second patterns picked-up from the same substrate ("pattern comparing method one unit pattern is compared with another

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unit pattern having the same shape and size" at column 1, line 23). Kobayashi describes how the traditional "database comparing method requires a lot of inspecting time and covers a lot of design data" (column 1, line 27) and that "the pattern comparing method is preferable to the database comparing method for inspection of complex photomask patterns" (column 1, line 29).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to modify the Lebeau system by picking up both the taught and run images from the same substrate as taught by Kobayashi, thus realizing the benefits of the pattern comparing method taught by Kobayashi including the reduction of inspection time when inspecting the complex patterns of a semiconductor device, and eliminating the need to process and store a reference for comparison (as the normally identical semiconductor devices on a wafer are compared with each other).

Regarding the second difference (i.e., the claim limitation that requires alignment to a single pixel unit), Danielson discloses a system in the same field of substrate pattern inspection (figure 1; the mask is depicted as numeral 24) and same problem solving area of image alignment (figure 1, numeral 66), comprising an alignment means for aligning first and second images (figure 1, numeral 66) with an accuracy of one pixel unit ("alignment system includes ... detection of alignment errors in excess of +/- 1 pixel" at column 6, line 11).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to align the two images as required by the above Lebeau and Kobayashi combination, with an accuracy of one pixel unit using the alignment means taught by

Danielson, in order to “compensate for registration errors present when comparison of a [substrate] is made ... where spatial resolution of the automatic system is very high and the inspection speed rapid” (Danielson, column 6, line 2), such that “alignment can be properly maintained in the presence of large areas devoid of patterns” (Danielson, column 6, line 19), and ultimately to provide a “high speed, continuous process” where “no stopping or restriction of the pixel stream is necessary, and continuous correction of alignment can be performed” (Danielson, column 14, line 60).

Regarding dependent claims 7 and 27 specifically, while Lebeau teaches “recording locations of bright defects 56 and dark defects 54 for later analysis” at column 7, line 24, Lebeau does not specifically teach displaying the detected defects and the information of features of the detected defects on a screen.

Kobayashi also teaches displaying the detected defects and information of features of the detected defects on a screen (“human inspector can check the inspection results by observing the stored data in the stage coordinate memory 300 on the inspection output device 400 such as a cathode-ray tube” at column 4, line 12; the features include “the stage position at which there is a defect” at line 5; thus, given that each defect detected is output to the operator on a CRT, the defects are displayed; that the claim does not require any particular form of visual display, only that the defects are displayed; also, given that the coordinates of where the defect exists are displayed, information about the defects is displayed).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to display the detected defects and information of detected defect features

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on a screen in the Lebeau, Kobayashi and Danielson combination as further taught by Kobayashi, in order to allow a human operator to immediately and visually review and analyze the results of inspection and thus take immediate action, or make decisions regarding the inspected semiconductor under inspection.

Regarding the third difference, Michael discloses a system in the same field of image processing, and specifically in the same sub-field of comparing a image of a wafer with a reference to detect defects (figure 7), wherein Michael solves the same problem of matching brightness between the two images ("contrast normalization" at column 13, line 65). Michael teaches both a global gradation conversion (i.e., column 13, line 65) and a local gradation conversion ("local contrast normalization" at column 14, line 32) to locally to locally match a brightness of the first image with a brightness of the second image (equation 6 at column 14, line 40).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to modify the brightness normalization of Lebeau (i.e., the graylevels of the "[r]un image ... are then mapped based on a comparison of the mean brightness of the taught image to that of the run image" so "the mean brightness level ... is the same as the mean value of taught image" at Lebeau's column 5, lines 50-54), to also locally match brightness as taught by Michael, in order to prevent improve matching accuracy by compensating for "conditions that cause image intensity to vary slowly with position in the image" (Michael, column 14, line 35).

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11. Claim 1, 5, 7, 15, 21 and 27-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Lebeau (US 5,204,910 – art of record), Kobayashi et al. (US 4,669,123 – art of record), Danielson et al. (US 4,926,489 A – new art) and Schemmel et al. (US 6,504,948 B1).

Lebeau discloses a system that aligns and compares first and second images (i.e., a test and reference image of a semiconductor) to detect defects. More specifically, discloses the alignment (“registered” and “rotation and spatial position” at column 3, line 60) and comparison of images of patterns in two images (“compared by algebraically subtracting the respective graylevel values at each pixel location” at column 6, line 56; “bright defects” and “dark defects” are detected at column 7, line 24). The content of the Lebeau reference was addressed in the previous Office Actions; the details of which are incorporated herein by reference and will not be repeated for the sake of brevity.

First Difference:

Lebeau does not teach the image of the second pattern being formed on the same substrate as the first.

Second Difference:

Lebeau does not teach the aligning having an accuracy of one pixel unit.

Third Difference:

While Lebeau discloses gradation conversion means for performing gradation conversion to match a brightness of one image to that of the other (i.e., the graylevels of the “[r]un image ... are then mapped based on a comparison of the mean brightness of

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the taught image to that of the run image” so “the mean brightness level ... is the same as the mean value of taught image” at column 5, lines 50-54), Lebeau does not teach a “local” gradation conversion of one of the first or second images to “locally match a brightness of the first image with a brightness of the second image” as claimed.

Regarding the first difference (i.e., the claim limitation that requires the image of the second pattern to be formed on the same substrate as the first), Kobayashi discloses a system in the same field of semiconductor defect inspection (“inspecting method and apparatus” and “semiconductor device” at column 1, line 7), wherein Kobayashi teaches comparing images of first and second patterns picked-up from the same substrate (“pattern comparing method one unit pattern is compared with another unit pattern having the same shape and size” at column 1, line 23). Kobayashi describes how the traditional “database comparing method requires a lot of inspecting time and covers a lot of design data” (column 1, line 27) and that “the pattern comparing method is preferable to the database comparing method for inspection of complex photomask patterns” (column 1, line 29).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to modify the Lebeau system by picking up both the taught and run images from the same substrate as taught by Kobayashi, thus realizing the benefits of the pattern comparing method taught by Kobayashi including the reduction of inspection time when inspecting the complex patterns of a semiconductor device, and eliminating the need to process and store a reference for comparison (as the normally identical semiconductor devices on a wafer are compared with each other).

Regarding the second difference (i.e., the claim limitation that requires alignment to a single pixel unit), Danielson discloses a system in the same field of substrate pattern inspection (figure 1; the mask is depicted as numeral 24) and same problem solving area of image alignment (figure 1, numeral 66), comprising an alignment means for aligning first and second images (figure 1, numeral 66) with an accuracy of one pixel unit ("alignment system includes ... detection of alignment errors in excess of +/- 1 pixel" at column 6, line 11).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to align the two images as required by the above Lebeau and Kobayashi combination, with an accuracy of one pixel unit using the alignment means taught by Danielson, in order to "compensate for registration errors present when comparison of a [substrate] is made ... where spatial resolution of the automatic system is very high and the inspection speed rapid" (Danielson, column 6, line 2), such that "alignment can be properly maintained in the presence of large areas devoid of patterns" (Danielson, column 6, line 19), and ultimately to provide a "high speed, continuous process" where "no stopping or restriction of the pixel stream is necessary, and continuous correction of alignment can be performed" (Danielson, column 14, line 60).

Regarding dependent claims 7 and 27 specifically, while Lebeau teaches "recording locations of bright defects 56 and dark defects 54 for later analysis" at column 7, line 24, Lebeau does not specifically teach displaying the detected defects and the information of features of the detected defects on a screen.

Kobayashi also teaches displaying the detected defects and information of features of the detected defects on a screen ("human inspector can check the inspection results by observing the stored data in the stage coordinate memory 300 on the inspection output device 400 such as a cathode-ray tube" at column 4, line 12; the features include "the stage position at which there is a defect" at line 5; thus, given that each defect detected is output to the operator on a CRT, the defects are displayed; that the claim does not require any particular form of visual display, only that the defects are displayed; also, given that the coordinates of where the defect exists are displayed, information about the defects is displayed).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to display the detected defects and information of detected defect features on a screen in the Lebeau, Kobayashi and Danielson combination as further taught by Kobayashi, in order to allow a human operator to immediately and visually review and analyze the results of inspection and thus take immediate action, or make decisions regarding the inspected semiconductor under inspection.

Regarding the third difference, Schemmel discloses a system in the same field of image processing, and specifically in the same sub-field of matching a source wafer image with a reference wafer image though image comparison (figures 1, 2 and 5), wherein Schemmel solves the same problem of matching brightness between the two images (i.e., "variations in ... background reflectivity" at column 12, line 21). Schemmel teaches a local gradation conversion to locally match a brightness of the first image with

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a brightness of the second image ("automatically adjusts the relative gray scale values recorded for each neighborhood of pixels within a silicon chip" at column 12, line 25).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to modify the brightness normalization of Lebeau (i.e., the graylevels of the "[r]un image ... are then mapped based on a comparison of the mean brightness of the taught image to that of the run image" so "the mean brightness level ... is the same as the mean value of taught image" at Lebeau's column 5, lines 50-54), to locally match brightness specifically at "neighborhoods" as taught by Schemmel, in order to compensate for variation in background reflectivity and "intrinsic variations in the processing of different batches of silicon wafers" (Schemmel, column 12, lines 20-25) thus preventing the false identification of defects due to normal variations between a test and a reference image.

12. Claims 15, 18 and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Wihl (US 4,633,504 A – art of record), Danielson et al. (US 4,926,489 A – new art) and Koike et al. (US 6,181,805 B1).

Wihl discloses a system that aligns and compares first and second images (i.e., a test and reference image of a semiconductor) to detect defects. The content of the Wihl reference as described in the previous Office Actions is incorporated herein by reference, the details of which will not be repeated for the sake of brevity.

First Difference:

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While Wihl discloses an alignment means for aligning the first and second images (figure 2, numeral 66), Wihl does not disclose the accuracy of the alignment. Specifically, Wihl does not teach the alignment of the two images with an accuracy of one pixel unit as now claimed.

Second Difference:

While Wihl discloses local gradation conversion means for performing local gradation conversion to correct a brightness (figure 2, numerals 54 and 56; "7 X 7 Finite Impulse Response filter" that "produces a corrected pixel of the output as the weighted sum of each pixel of input and its nearest 48 neighbors" at column 2, line 50), Wihl does not teach a "local" gradation conversion of one of the first or second images to "locally match a brightness of the first image with a brightness of the second image" as claimed.

Regarding the first difference, Danielson discloses a system in the same field of pattern inspection, and particularly photomask inspection (figure 1; the mask is depicted as numeral 24), and same problem solving area of image alignment (figure 1, numeral 66), comprising an alignment means for aligning first and second images (figure 1, numeral 66) with an accuracy of one pixel unit ("alignment system includes ... detection of alignment errors in excess of +/- 1 pixel" at column 6, line 11).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to align the two images as required by Wihl, with an accuracy of one pixel unit using the alignment means taught by Danielson, in order to "compensate for registration errors present when comparison of a reticle or photomask is made ... where spatial resolution of the automatic system is very high and the inspection speed rapid"

(Danielson, column 6, line 2), such that "alignment can be properly maintained in the presence of large areas devoid of patterns" (Danielson, column 6, line 19), and ultimately to provide a "high speed, continuous process" where "no stopping or restriction of the pixel stream is necessary, and continuous correction of alignment can be performed" (Danielson, column 14, line 60).

Regarding the second difference, Koike discloses a system in the same field of image processing, and specifically in the same sub-field of matching a source image with a reference image through image comparison ("image of an object having features ... matched to dictionary or library images" at column 1, lines 6-8), wherein Koike solves the same problem of matching brightness between the two images (i.e., "normalization sec." At figure 20, numerals 137 and 138). Koike teaches a local gradation conversion ("normalizing the brightness or lighting of the matching region" at column 14, line 47; a "region" is local within the image) of one of the first or second images (figure 20, numerals 137 and 138) to locally match a brightness of the first image with a brightness of the second image ("normalizing the brightness or lighting of the matching region in the test image and the dictionary image" at column 14, line 47; "transforming the intensity values of the respective pixels so that the mean value and the variance of the intensity of pixels in the matching region may coincide with predetermined values" or "convert, nonlinearly, the range between the maximum and minimum value of the intensity of pixels in the matching region to a range between predetermined maximum and minimum values" at column 14, lines 60+; "Owing to the normalization processing, it is possible to prevent lowering of the matching accuracy when the brightness of the

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object in the test image varies with a change in pose of the object, for example" at column 15, line 12).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to modify the brightness normalization of Wihl (i.e., that "produces a corrected pixel of the output as the weighted sum of each pixel of input and its nearest 48 neighbors" at column 2, line 50), to include locally matching brightness specifically at matching "regions" as taught by Koike, in order to prevent lowering of the matching accuracy when the brightness of the features in the test image varies from that of the reference image due to changes in ambient measurement conditions (i.e., as described by Koike at column 15, line 12).

13. Claims 15, 18 and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Wihl (US 4,633,504 A – art of record), Danielson et al. (US 4,926,489 A – new art) and Michael (US 5,640,200 A).

Wihl discloses a system that aligns and compares first and second images (i.e., a test and reference image of a semiconductor) to detect defects. The content of the Wihl reference as described in the previous Office Actions is incorporated herein by reference, the details of which will not be repeated for the sake of brevity.

First Difference:

While Wihl discloses an alignment means for aligning the first and second images (figure 2, numeral 66), Wihl does not disclose the accuracy of the alignment.

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Specifically, Wihl does not teach the alignment of the two images with an accuracy of one pixel unit as now claimed.

Second Difference:

While Wihl discloses local gradation conversion means for performing local gradation conversion to correct a brightness (figure 2, numerals 54 and 56; "7 X 7 Finite Impulse Response filter" that "produces a corrected pixel of the output as the weighted sum of each pixel of input and its nearest 48 neighbors" at column 2, line 50), Wihl does not teach a "local" gradation conversion of one of the first or second images to "locally match a brightness of the first image with a brightness of the second image" as claimed.

Regarding the first difference, Danielson discloses a system in the same field of pattern inspection, and particularly photomask inspection (figure 1; the mask is depicted as numeral 24), and same problem solving area of image alignment (figure 1, numeral 66), comprising an alignment means for aligning first and second images (figure 1, numeral 66) with an accuracy of one pixel unit ("alignment system includes ... detection of alignment errors in excess of +/- 1 pixel" at column 6, line 11).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to align the two images as required by Wihl, with an accuracy of one pixel unit using the alignment means taught by Danielson, in order to "compensate for registration errors present when comparison of a reticle or photomask is made ... where spatial resolution of the automatic system is very high and the inspection speed rapid" (Danielson, column 6, line 2), such that "alignment can be properly maintained in the presence of large areas devoid of patterns" (Danielson, column 6, line 19), and

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ultimately to provide a "high speed, continuous process" where "no stopping or restriction of the pixel stream is necessary, and continuous correction of alignment can be performed" (Danielson, column 14, line 60).

Regarding the second difference, Michael discloses a system in the same field of image processing, and specifically in the same sub-field of comparing a image of a wafer with a reference to detect defects (figure 7), wherein Michael solves the same problem of matching brightness between the two images ("contrast normalization" at column 13, line 65). Michael teaches both a global gradation conversion (i.e., column 13, line 65) and a local gradation conversion ("local contrast normalization" at column 14, line 32) to locally to locally match a brightness of the first image with a brightness of the second image (equation 6 at column 14, line 40).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to modify the brightness normalization of Wihl (i.e., that "produces a corrected pixel of the output as the weighted sum of each pixel of input and its nearest 48 neighbors" at column 2, line 50), to include locally matching brightness as taught by Michael, in order to prevent improve matching accuracy by compensating for "conditions that cause image intensity to vary slowly with position in the image" (Michael, column 14, line 35).

14. Claims 15, 18 and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Wihl (US 4,633,504 A – art of record), Danielson et al. (US 4,926,489 A – new art) and Schemmel et al. (US 6,504,948 B1).

Wihl discloses a system that aligns and compares first and second images (i.e., a test and reference image of a semiconductor) to detect defects. The content of the Wihl reference as described in the previous Office Actions is incorporated herein by reference, the details of which will not be repeated for the sake of brevity.

First Difference:

While Wihl discloses an alignment means for aligning the first and second images (figure 2, numeral 66), Wihl does not disclose the accuracy of the alignment. Specifically, Wihl does not teach the alignment of the two images with an accuracy of one pixel unit as now claimed.

Second Difference:

While Wihl discloses local gradation conversion means for performing local gradation conversion to correct a brightness (figure 2, numerals 54 and 56; “7 X 7 Finite Impulse Response filter” that “produces a corrected pixel of the output as the weighted sum of each pixel of input and its nearest 48 neighbors” at column 2, line 50), Wihl does not teach a “local” gradation conversion of one of the first or second images to “locally match a brightness of the first image with a brightness of the second image” as claimed.

Regarding the first difference, Danielson discloses a system in the same field of pattern inspection, and particularly photomask inspection (figure 1; the mask is depicted as numeral 24), and same problem solving area of image alignment (figure 1, numeral 66), comprising an alignment means for aligning first and second images (figure 1, numeral 66) with an accuracy of one pixel unit (“alignment system includes ... detection of alignment errors in excess of +/- 1 pixel” at column 6, line 11).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to align the two images as required by Wihl, with an accuracy of one pixel unit using the alignment means taught by Danielson, in order to "compensate for registration errors present when comparison of a reticle or photomask is made ... where spatial resolution of the automatic system is very high and the inspection speed rapid" (Danielson, column 6, line 2), such that "alignment can be properly maintained in the presence of large areas devoid of patterns" (Danielson, column 6, line 19), and ultimately to provide a "high speed, continuous process" where "no stopping or restriction of the pixel stream is necessary, and continuous correction of alignment can be performed" (Danielson, column 14, line 60).

Regarding the second difference, Schemmel discloses a system in the same field of image processing, and specifically in the same sub-field of matching a source wafer image with a reference wafer image through image comparison (figures 1, 2 and 5), wherein Schemmel solves the same problem of matching brightness between the two images (i.e., "variations in ... background reflectivity" at column 12, line 21). Schemmel teaches a local gradation conversion to locally match a brightness of the first image with a brightness of the second image ("automatically adjusts the relative gray scale values recorded for each neighborhood of pixels within a silicon chip" at column 12, line 25).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to modify the brightness normalization of Wihl (i.e., that "produces a corrected pixel of the output as the weighted sum of each pixel of input and its nearest 48 neighbors" at column 2, line 50), to include locally matching brightness specifically at

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“neighborhoods” as taught by Schemmel, in order to compensate for variation in background reflectivity and “intrinsic variations in the processing of different batches of silicon wafers” (Schemmel, column 12, lines 20-25) thus preventing the false identification of defects due to normal variations between a test and a reference image.

15. Claims 6, 19 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Lebeau (US 5,204,910 – art of record), Kobayashi et al. (US 4,669,123 – art of record), Danielson et al. (US 4,926,489 A – new art) and Koike et al. (US 6,181,805 B1) as applied to claims 1, 15 and 27 above, and further in view of Wagner et al. (US 5,659,172 – art of record).

Regarding each of these claims, Lebeau as part of the Lebeau, Kobayashi, Danielson and Koike combination does not disclose picking up the first and second images using an electron beam.

Wagner discloses a system in the same field of endeavor of semiconductor wafer inspection (“detection of defects on semiconductor wafers” at column 1, line 11), comprising picking up images to be inspected using an electron beam (figure 1, numeral 32; see “SEM 22 electron beam 32” at column 4, line 64; “images of an area of the semiconductor wafer which is to be inspected” at column 3, line 2).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to utilize an electron beam scanner as taught by Wagner, as the image pick-up source of the Lebeau, Kobayashi, Danielson and Koike combination, in order to detect defects the size of which “falls below the resolution of conventional light optics”

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(Wagner, column 1, line 43) because of the scanning microscope's ability to resolve "features more that an order of magnitude smaller than the wavelength of visible light" (Wagner, column 1, line 51), thereby improving defect detection sensitivity and thus accuracy.

16. Claims 6, 19 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Lebeau (US 5,204,910 – art of record), Kobayashi et al. (US 4,669,123 – art of record), Danielson et al. (US 4,926,489 A – new art) and Michael (US 5,640,200 A) as applied to claims 1, 15 and 27 above, and further in view of Wagner et al. (US 5,659,172 – art of record).

Regarding each of these claims, Lebeau as part of the Lebeau, Kobayashi, Danielson and Michael combination does not disclose picking up the first and second images using an electron beam.

Wagner discloses a system in the same field of endeavor of semiconductor wafer inspection ("detection of defects on semiconductor wafers" at column 1, line 11), comprising picking up images to be inspected using an electron beam (figure 1, numeral 32; see "SEM 22 electron beam 32" at column 4, line 64; "images of an area of the semiconductor wafer which is to be inspected" at column 3, line 2).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to utilize an electron beam scanner as taught by Wagner, as the image pick-up source of the Lebeau, Kobayashi, Danielson and Michael combination, in order to detect defects the size of which "falls below the resolution of conventional light optics"

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(Wagner, column 1, line 43) because of the scanning microscope's ability to resolve "features more that an order of magnitude smaller than the wavelength of visible light" (Wagner, column 1, line 51), thereby improving defect detection sensitivity and thus accuracy.

17. Claims 6, 19 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Lebeau (US 5,204,910 – art of record), Kobayashi et al. (US 4,669,123 – art of record), Danielson et al. (US 4,926,489 A – new art) and Schemmel et al. (US 6,504,948 B1) as applied to claims 1, 15 and 27 above, and further in view of Wagner et al. (US 5,659,172 – art of record).

Regarding each of these claims, Lebeau as part of the Lebeau, Kobayashi, Danielson and Schemmel combination does not disclose picking up the first and second images using an electron beam.

Wagner discloses a system in the same field of endeavor of semiconductor wafer inspection ("detection of defects on semiconductor wafers" at column 1, line 11), comprising picking up images to be inspected using an electron beam (figure 1, numeral 32; see "SEM 22 electron beam 32" at column 4, line 64; "images of an area of the semiconductor wafer which is to be inspected" at column 3, line 2).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to utilize an electron beam scanner as taught by Wagner, as the image pick-up source of the Lebeau, Kobayashi, Danielson and Schemmel combination, in order to detect defects the size of which "falls below the resolution of conventional light

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optics" (Wagner, column 1, line 43) because of the scanning microscope's ability to resolve "features more that an order of magnitude smaller than the wavelength of visible light" (Wagner, column 1, line 51), thereby improving defect detection sensitivity and thus accuracy.

18. Claims 2 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Lebeau (US 5,204,910 – art of record), Kobayashi et al. (US 4,669,123 – art of record), Danielson et al. (US 4,926,489 A – new art) and Koike et al. (US 6,181,805 B1) as applied to claims 1 and 15 above, and further in view of Haskell et al. (US 6,111,596 – art of record).

Lebeau discloses an adjustment of the two images "so that their overall brightness is the same" as described at column 5, line 20. While Lebeau describes one embodiment that compares "the mean brightness level of the two images" at column 5, line 25, Lebeau does not teach a linear conversion of the gain and offset so that the brightness of the images can be made equal. Lebeau states that "[o]ther embodiments use techniques such as ... video amplifier gain ... to match the brightness of the representations of the images" at column 5, line 25. Lebeau is not limited to any one method.

Haskell discloses an image process system in the same field of endeavor of adjusting the two images so that their overall brightness is the same ("mismatch in brightness and/or color balance between the two views of a scene due to differences in imaging parameters is rectified" at column 4, line 15), comprising matching the

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brightness of two images by means of a linear conversion of gain and offset ("gain and offset differences not only for luminance but also for chrominance are corrected" at column 4, line 13; specifically, see "Method 1" at column 6, line 20; "gain and offset values that must be applied to the right-view image to correct for mismatch can be obtained by solving two simultaneous equations" at column 6, line 34; the equation for gain, "a", is at column 6, line 47 and offset, "b" at line 43; the equations are linear [i.e., not exponential] and thus the correction is linear). The technique of method 1 is best applied to "images having histograms with at least two uniquely identifiable points with ... 'very dark' and 'very bright' contents" as described at column 6, line 21, and this is exactly the situation with Lebeau (see figures 7-9).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to modify the Lebeau, Kobayashi, Danielson and Koike combination by matching the brightness of the Lebeau images using a linear conversion of gain and offset as taught by Haskell, in order to more accurately correct for image brightness difference by factoring in both gain and offset, as opposed to just a simple histogram shift as is currently disclosed by Lebeau (see figures 8 and 9 which depict a simple histogram shift), and to provide the additional benefit of correcting a chrominance mismatch (in addition to the luminance, or brightness) thereby providing Lebeau the ability to utilize color images, to more accurately represent the semiconductor under inspection.

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19. Claims 2 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Lebeau (US 5,204,910 – art of record), Kobayashi et al. (US 4,669,123 – art of record), Danielson et al. (US 4,926,489 A – new art) and Michael (US 5,640,200 A) as applied to claims 1 and 15 above, and further in view of Haskell et al. (US 6,111,596 – art of record).

Lebeau discloses an adjustment of the two images “so that their overall brightness is the same” as described at column 5, line 20. While Lebeau describes one embodiment that compares “the mean brightness level of the two images” at column 5, line 25, Lebeau does not teach a linear conversion of the gain and offset so that the brightness of the images can be made equal. Lebeau states that “[o]ther embodiments use techniques such as ... video amplifier gain ... to match the brightness of the representations of the images” at column 5, line 25. Lebeau is not limited to any one method.

Haskell discloses an image process system in the same field of endeavor of adjusting the two images so that their overall brightness is the same (“mismatch in brightness and/or color balance between the two views of a scene due to differences in imaging parameters is rectified” at column 4, line 15), comprising matching the brightness of two images by means of a linear conversion of gain and offset (“gain and offset differences not only for luminance but also for chrominance are corrected” at column 4, line 13; specifically, see “Method 1” at column 6, line 20; “gain and offset values that must be applied to the right-view image to correct for mismatch can be obtained by solving two simultaneous equations” at column 6, line 34; the equation for

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gain, "a", is at column 6, line 47 and offset, "b" at line 43; the equations are linear [i.e., not exponential] and thus the correction is linear). The technique of method 1 is best applied to "images having histograms with at least two uniquely identifiable points with ... 'very dark' and 'very bright' contents" as described at column 6, line 21, and this is exactly the situation with Lebeau (see figures 7-9).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to modify the Lebeau, Kobayashi, Danielson and Michael combination by matching the brightness of the Lebeau images using a linear conversion of gain and offset as taught by Haskell, in order to more accurately correct for image brightness difference by factoring in both gain and offset, as opposed to just a simple histogram shift as is currently disclosed by Lebeau (see figures 8 and 9 which depict a simple histogram shift), and to provide the additional benefit of correcting a chrominance mismatch (in addition to the luminance, or brightness) thereby providing Lebeau the ability to utilize color images, to more accurately represent the semiconductor under inspection.

20. Claims 2 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Lebeau (US 5,204,910 – art of record), Kobayashi et al. (US 4,669,123 – art of record), Danielson et al. (US 4,926,489 A – new art) and Schemmel et al. (US 6,504,948 B1) as applied to claims 1 and 15 above, and further in view of Haskell et al. (US 6,111,596 – art of record).

Lebeau discloses an adjustment of the two images "so that their overall brightness is the same" as described at column 5, line 20. While Lebeau describes one embodiment that compares "the mean brightness level of the two images" at column 5, line 25, Lebeau does not teach a linear conversion of the gain and offset so that the brightness of the images can be made equal. Lebeau states that "[o]ther embodiments use techniques such as ... video amplifier gain ... to match the brightness of the representations of the images" at column 5, line 25. Lebeau is not limited to any one method.

Haskell discloses an image process system in the same field of endeavor of adjusting the two images so that their overall brightness is the same ("mismatch in brightness and/or color balance between the two views of a scene due to differences in imaging parameters is rectified" at column 4, line 15), comprising matching the brightness of two images by means of a linear conversion of gain and offset ("gain and offset differences not only for luminance but also for chrominance are corrected" at column 4, line 13; specifically, see "Method 1" at column 6, line 20; "gain and offset values that must be applied to the right-view image to correct for mismatch can be obtained by solving two simultaneous equations" at column 6, line 34; the equation for gain, "a", is at column 6, line 47 and offset, "b" at line 43; the equations are linear [i.e., not exponential] and thus the correction is linear). The technique of method 1 is best applied to "images having histograms with at least two uniquely identifiable points with ... 'very dark' and 'very bright' contents" as described at column 6, line 21, and this is exactly the situation with Lebeau (see figures 7-9).

It would have been obvious at the time the invention was made to one of ordinary skill in the art to modify the Lebeau, Kobayashi, Danielson and Schemmel combination by matching the brightness of the Lebeau images using a linear conversion of gain and offset as taught by Haskell, in order to more accurately correct for image brightness difference by factoring in both gain and offset, as opposed to just a simple histogram shift as is currently disclosed by Lebeau (see figures 8 and 9 which depict a simple histogram shift), and to provide the additional benefit of correcting a chrominance mismatch (in addition to the luminance, or brightness) thereby providing Lebeau the ability to utilize color images, to more accurately represent the semiconductor under inspection.

21. Claims 31, 33 and 35 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Lee et al. (US 5,808,735 A – art of record), Danielson et al. (US 4,926,489 A – new art) and Koike et al. (US 6,181,805 B1) as applied to claims 1, 8 and 22 respectively, and further in view of Teo (US 6,128,108 A – new art).

Lee as modified by Koike and as part of the Lee, Danielson and Koike combination, teaches a local gradation conversion means for performing local gradation conversion to correct a brightness of each of a plurality of pixels in the images and thereby match the brightness of one image to that of the other as described in the rejection above. Specifically, Koike was relied upon as teaching a local gradation conversion. Koike teaches two methods for matching local brightness including a mean

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and variance transformation (Koike, column 14, line 61) and a max/min range transformation (Koike, column 14, line 65).

The Lee combination does not teach the local gradation conversion as minimizing a sum of squares of differences between the brightness of the first and second images.

Teo discloses a system in the same field of image processing (i.e., "the present invention relates to digital image processing" at column 1, line 5), and same problem solving area of normalizing two images, or matching the brightness of two images ("variation due to different lighting conditions is reduced" at column 2, line 64; images A and B "which were taken under different lighting conditions" at column 8, line 67; "bring the two images into line with one another. Specifically, brightness, contrast and gamma parameters ... are used to modify image color intensity" at column 9, line 7), comprising a local gradation conversion ("once the brightness, contrast and gamma parameters are determined, they are applied to image A" at column 10, line 27; it can be seen from equation 9 that the parameters are applied to each and every pixel as designated by "x,y" and thus the brightness conversion is local, or takes place in local areas) that minimizes a sum of squares of differences between the brightness of the first and second images ("seeks to match as best possible the color intensities of image A ... using a least sum of squares error criterion ... it seeks to minimize the deviation between the color intensities" at column 9, line 23; see equations 3).

It would have been obvious at the time the invention was made to one of ordinary skill in the art measure and correct the brightness differences between the images of

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Lee as modified by Koike, using the minimization of sum of least squares method taught by Tao, in order to reduce variations "due to different lighting conditions" in which the images were acquired (Tao, column 2, line 64), and thereby "bring the two images into line with one another" and specifically, with respect to "brightness, contrast and gamma parameters" (Tao, column 9, line 7), in a speedy and efficient manner (i.e., Tao, "fast modification of the image ... avoiding the need to compute equation (2) repeatedly" at column 10, line 65). In summary, the teaching of Tao would allow for all of the image parameters (i.e., brightness, contrast and gamma) to be normalized between the two images of Lee, instead of just the brightness alone as required, thereby providing a more accurate image normalization and thus further helping to reduce the indication of false defects due to mismatched images (Lee, column 6, line 16).

22. Claims 32, 34 and 36 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Lebeau (US 5,204,910 – art of record), Kobayashi et al. (US 4,669,123 – art of record), Danielson et al. (US 4,926,489 A – new art) and Koike et al. (US 6,181,805 B1) as applied to claims 7, 15 and 27 above, and further in view of Teo (US 6,128,108 A – new art).

Lebeau as modified by Koike and as part of the Lebeau, Kobayashi, Danielson and Koike combination, teaches local gradation conversion means for performing local gradation conversion to match a brightness of one image to that of the other as described above. Specifically, Koike was relied upon as teaching a local gradation conversion. Koike teaches two methods for matching local brightness including a mean

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and variance transformation (Koike, column 14, line 61) and a max/min range transformation (Koike, column 14, line 65).

The Lebeau combination does not teach the local gradation conversion as minimizing a sum of squares of differences between the brightness of the first and second images.

Teo discloses a system in the same field of image processing (i.e., "the present invention relates to digital image processing" at column 1, line 5), and same problem solving area of normalizing two images, or matching the brightness of two images ("variation due to different lighting conditions is reduced" at column 2, line 64; images A and B "which were taken under different lighting conditions" at column 8, line 67; "bring the two images into line with one another. Specifically, brightness, contrast and gamma parameters ... are used to modify image color intensity" at column 9, line 7), comprising a local gradation conversion ("once the brightness, contrast and gamma parameters are determined, they are applied to image A" at column 10, line 27; it can be seen from equation 9 that the parameters are applied to each and every pixel as designated by "x,y" and thus the brightness conversion is local, or takes place in local areas) that minimizes a sum of squares of differences between the brightness of the first and second images ("seeks to match as best possible the color intensities of image A ... using a least sum of squares error criterion ... it seeks to minimize the deviation between the color intensities" at column 9, line 23; see equations 3).

It would have been obvious at the time the invention was made to one of ordinary skill in the art measure and correct the brightness differences between the images of

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Lebeau as part of the Lebeau, Kobayashi, Danielson and Koike combination, using the minimization of sum of least squares method taught by Tao, in order to reduce variations "due to different lighting conditions" in which the images were acquired (Tao, column 2, line 64), and thereby "bring the two images into line with one another" and specifically, with respect to "brightness, contrast and gamma parameters" (Tao, column 9, line 7), in a speedy and efficient manner (i.e., Tao, "fast modification of the image ... avoiding the need to compute equation (2) repeatedly" at column 10, line 65). In summary, the teaching of Tao would allow for all of the image parameters (i.e., brightness, contrast and gamma) to be normalized between the two images of Lebeau, instead of just the brightness alone as required, thereby providing a more accurate image normalization and thus further helping to match the two images for subsequent comparison (Lebeau, "match the desired run image greylevels" at column 8, line 56).

Conclusion

23. Suggestions: It is clear from the prior art that local gradation conversion to match brightness between source and reference images is well known in the art. Patentability will not result from the claimed local gradation conversion, or a local matching of brightness per se. Patentability will most likely result from the claimed clarification of "local", in addition to a claimed clarification of how the gradation conversion is performed as described at specification pages 17+.

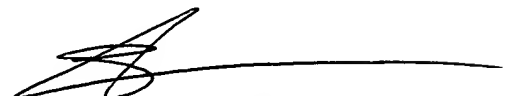
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24. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Brian P. Werner whose telephone number is 703-306-3037. The examiner can normally be reached on M-F, 8:00 - 4:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Leo H. Boudreau can be reached on 703-305-4706. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9314 for regular communications and 703-872-9314 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-305-4750.

Brian Werner
Primary Examiner
May 7, 2003



BRIAN WERNER
PRIMARY EXAMINER